Aerothermodynamic Testing Of Aerocapture and Planetary Probe Geometries In Hypersonic Ballistic–Range Environments

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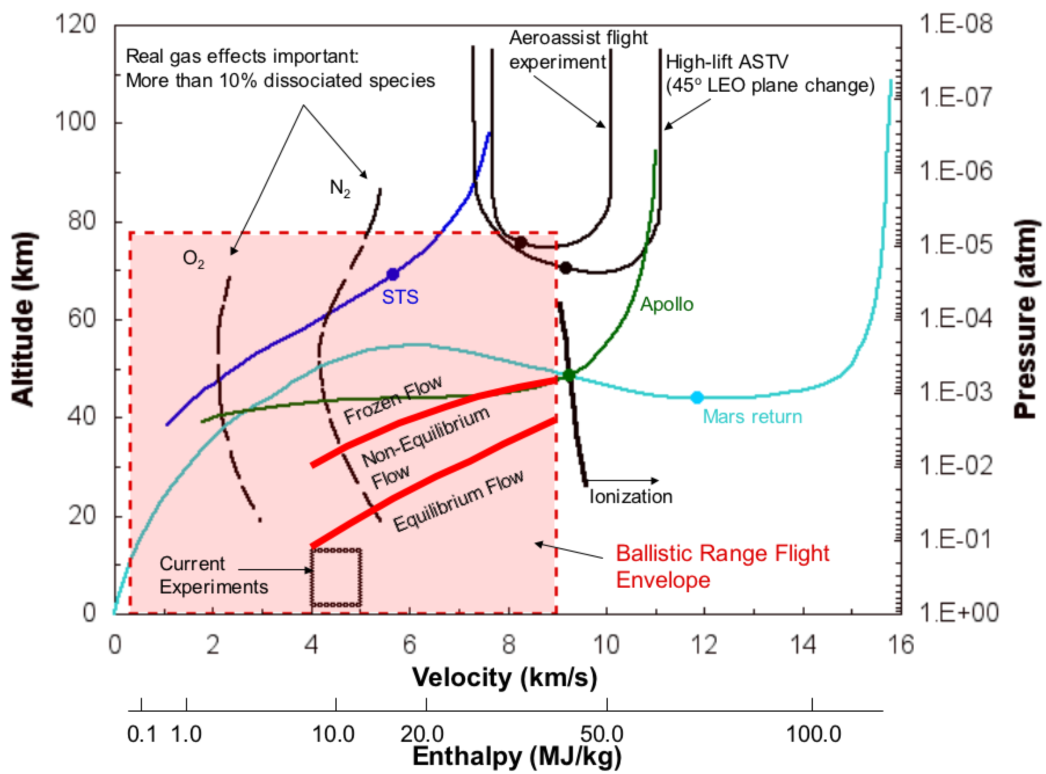
Introduction

- Flight data needed to validate and verify aerothermodynamic design methods
- Not always possible to instrument actual entry vehicles, and dedicated flight experiments are expensive
- Consequently, design methods must be validated against experiments in ground-test facilities
  - Wind tunnels, arcjets, shock tubes/tunnels, ballistic ranges
- No single facility type can reproduce all parameters of full-scale hypersonic atmospheric-entry flight
  - Different facility types complement each other by providing validation data over largest possible parameter space
  - Available flight data helps verify traceability between ground-test and flight conditions

Ballistic-Range Testing

- Ballistic-range uniquely provides opportunity for small-scale flight test
- Hypersonic flight through a quiescent, well characterized atmosphere
- Correct flight enthalpy and Mach number
- Real-gas effects with uncontaminated chemistry
- Broad operational envelope
  - Flight velocity and effective altitude (freestream pressure) are independently variable
  - V_∞ up to 9 km/s ($h_{stag} \approx 40$ MJ/kg)
  - P_∞ from 0.005 atm to 1.0 atm
  - Selectable test atmosphere: Air, CO_2, N_2, He, Ar, Kr, Xe, etc.

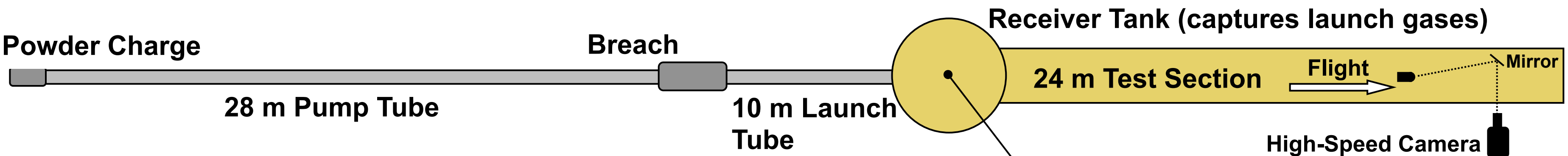
Flight Domain Simulation Capability

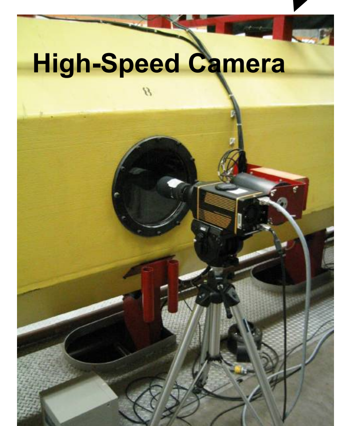


NASA-Ames Hypervelocity Free-Flight Facility

Ames Research Center

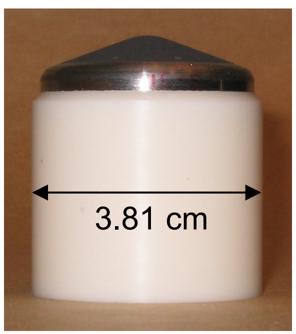
Reacting Flow Environments Branch — **Space Technology Division**



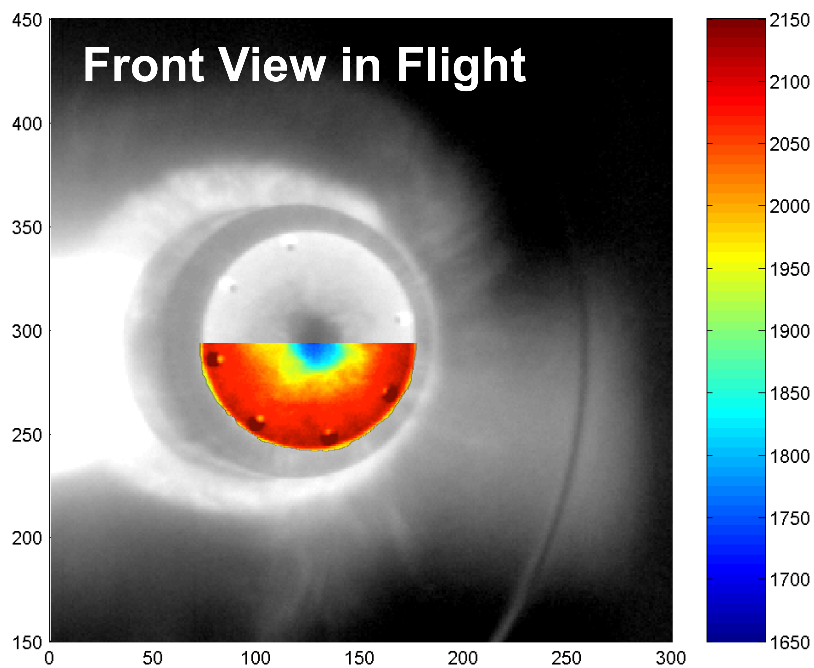


Model: 70° Sphere-Cone Cylindrical Afterbody (for in-barrel launch stability)

Side View



Front View



Representative Results